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Fall Chum Salmon Mark–Recapture Abundance Estimation on the Tanana and Kantishna Rivers, 2005

Annual Report for Study FIS 05-210
USFWS Office of Subsistence Management
Fisheries Information Services Division

by

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and

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December 2006

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 06-67

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TABLE OF CONTENTS

Page

LIST OF TABLES ii

LIST OF FIGURES ii

LIST OF APPENDICES ii

ABSTRACT 1

INTRODUCTION 1

METHODS 2

Tag Deployment 2
Tag Recovery 3
Data Analysis 3
Mark–recapture Assumption Tests 3
Abundance Estimation 3
Migration Rate 4
Stock Timing 4

RESULTS 4

Tag Deployment 4
Tag Recovery 5
Data Analysis 5
Mark–recapture Assumption Tests 5
Abundance Estimate 5
Migration Rate 6
Stock Timing 6

DISCUSSION 6

ACKNOWLEDGMENTS 7

REFERENCES CITED 8

TABLES AND FIGURES 9

APPENDIX A 23

LIST OF TABLES

Table **Page**

1. Tags recovered by location from fall chum salmon in the Tanana and Kantishna Rivers, 2005. 10
2. Statistical test results for fall chum salmon captured in the Toklat, upper Kantishna, and Tanana River tag recovery fish wheels, 2005. 11
3. Chi square test data and strata for marked ratio through time for fall chum salmon captured at the Tanana, upper Kantishna, and Toklat River tag recovery fish wheels, 2005. 12
4. Inseason daily and cumulative catch and abundance estimates of fall chum salmon in the Tanana River, 2005. 13
5. Inseason daily and cumulative catch and abundance estimates of fall chum salmon in the Kantishna River, 2005. 14
6. Estimated migration rates for day and night caught fall chum salmon in the Tanana and Kantishna Rivers, 1995–2005. 15
7. Tanana and Kantishna Rivers fall chum salmon abundance estimates, 1995–2005. 16

LIST OF FIGURES

Figure **Page**

1. Fishery management districts and sub-districts in the Yukon and Tanana River drainages. 17
2. Location of tag deployment and recovery wheels used in the Tanana and Kantishna River fall chum salmon mark–recapture project. 18
3. Daily fall chum salmon CPUE at the Tanana River tagging and recovery fish wheels, and CPUE at the Kantishna River tag deployment wheel and recovery fish wheels on the Toklat and upper Kantishna Rivers, 2005. 19
4. Fall chum salmon inseason abundance estimates for the Tanana and Kantishna Rivers, 2005 and abundance estimates for the Tanana River, 1995–2005 and Kantishna River, 1999–2005. 20
5. Tanana River water levels as measured by a U.S. Geological Survey gauge located near Nenana. 21

LIST OF APPENDICES

Appendix **Page**

A1. Daily effort and catch of fall chum salmon at the Tanana River tag deployment fish wheel, 2005. 24
A2. Daily effort and catch of fall chum salmon at the Kantishna River tag deployment fish wheel, 2005. 26
A3. Daily effort and catch of fall chum salmon at the Tanana River recovery fish wheel, 2005. 28
A4. Daily effort and catch of fall chum salmon at the Toklat River recovery fish wheels, (both combined), 2005. 30
A5. Daily effort and catch of fall chum salmon at the Kantishna River recovery fish wheels, (both combined), 2005. 32
A6. Daily effort and catch of coho salmon at the Tanana/Kantishna River mark–recapture project fish wheels, 2005. 34
A7. Water temperatures at the Tanana/Kantishna River mark–recapture project fish wheels, 2003–2005, and the Toklat River Springs (Geiger Creek), 2004–2005. 36

ABSTRACT

Fall chum salmon *Oncorhynchus keta* fish wheel mark–recapture studies have been conducted since 1995 on the Tanana River and since 1999 on the Kantishna River. In the Tanana River, chum salmon were captured and tagged using a fish wheel and recaptured in a second fish wheel 73 km upstream. In the Kantishna River, chum salmon were captured and tagged using a fish wheel, and recaptured at 2 different sites: the Toklat River, 89 km upstream, and the upper Kantishna River, 148km upstream. Fall chum salmon abundance estimates using the Darroch model were 337,755 (SE = 22,166) for the Tanana River and 107,719 (SE = 7,649) for the Kantishna River.

Key words: Tanana River, Kantishna River, chum salmon, *Oncorhynchus keta*, mark–recapture, fish wheel, abundance estimate.

INTRODUCTION

The Yukon River drainage is the largest in Alaska (854,700 km^2), and nearly one-third the area of the entire state (USGS 2005). Five species of Pacific salmon return to the Yukon River and its tributaries and are captured in subsistence, personal use, commercial, and sport fisheries. The Tanana River is the largest tributary of the Yukon River. It flows northwest through a broad alluvial valley for approximately 700 km to the Yukon River, with a watershed of 84,983 km^2 (ADNR 1991). Chum salmon *Oncorhynchus keta* return to the Yukon River in genetically divergent summer and fall runs (Seeb et al. 1995). Summer chum salmon enter the Yukon River in early May after the river is free of ice (Dunbar 2003) and fall chum salmon in mid-July (Sollee and Hayes 2003). The fall chum salmon (fall chum) migration usually peaks mid-September in the Tanana River and continues into early October (Cleary and Hamazaki 2005). Spawning occurs from October through November, generally in areas where upwelling ground water prevents freezing. Fall chum are larger on average, have higher oil content than summer chum (ADF&G 1994), and are important for subsistence, personal use, and commercial fisheries within the upper Yukon and Tanana Rivers (Brase and Hamner 2003).

For management purposes, the Yukon River drainage is divided into 13 Districts and Subdistricts. The Tanana River is called District 6, and is divided into Subdistricts 6-A, 6-B, and 6-C and the area upstream of Subdistrict 6-C to the headwaters is called the upper Tanana River area (Figure 1). For the purpose of the Tanana/Kantishna River mark–recapture project, the area upstream of Subdistrict 6-A is called the upper Tanana River (Figure 1). Tanana River summer and fall chum salmon are managed as separate stocks based on run timing and are divided into summer (before 16 August) and fall seasons (after 16 August), although some overlap in migration does occur. Tanana River fall chum run strength is assessed by using mark–recapture abundance estimates, catch per unit effort (CPUE) data from Alaska Department of Fish and Game (ADF&G) contracted "test" fish wheels (wheels), and historical fishery data.

Subsistence and personal use salmon fisheries occur in District 6 and are usually open for two 42-hour periods per week, with the exception of the "Old Minto" area where subsistence fishing is allowed 5 days a week. Subsistence fishing in the Kantishna River is usually open 7 days per week. Commercial fishing occurs on the Tanana River by emergency order. The Tanana River commercial guideline harvest range is 2,750–20,500 fall chum salmon, but the harvest level may be exceeded if assessment of run size indicates both escapement goals and subsistence needs will be met. In 2005, commercial fishing was permitted because of a strong return of fall chum (Bue and Lingnau 2005).

Tanana River fall chum are harvested in various fisheries in the Yukon drainage and represent a significant proportion of the total fall chum harvest in the Yukon drainage. For instance, in 2005

69,469 fall chum were harvested in District 6 of the Tanana River (B. Busher, Commercial Fisheries Biologist, ADF&G, Fairbanks; personal communication). This is approximately 25% of the 2005 total Alaska and Alaska-Canadian harvest combined and 58% of the 1995–2004 average total Alaska harvest (JTC 2006).

Primary objectives for this project are to provide management staff with inseason and postseason abundance estimates of fall chum in the Tanana (above the mouth of the Kantishna River) and Kantishna Rivers, and to estimate the migration rate of fall chum in the Kantishna River. Secondary objectives are to count tagged and untagged fall chum and other species using a digital video system at the Tanana tag recovery wheel, and to estimate run timing of fall chum to the Delta, Toklat, and Kantishna Rivers.

METHODS

TAG DEPLOYMENT

In 2005, two tag deployment wheels were operated by a contracted fishermen. One in the Tanana River, approximately 9 km upstream of the mouth of the Kantishna River, and the second was in the Kantishna River, approximately 3 km upstream (Figure 2). These locations are used because there are few tributaries between the tag deployment and recovery wheel sites, with the exception of the Tolovana River, upstream of the Tanana River tag deployment wheel. In the event that marked proportion changed over time at the Tanana River tag recovery wheel, tag colors were changed bi-weekly at the Tanana River tag deployment wheel. Tag color stratification can be used to generate a postseason abundance estimate using the Darroch stratified model (Darroch 1961).

The 2 tag deployment wheels were operated 24 hours per day unless interrupted by debris accumulation, repairs, adjustments, or relocation. At each location a daily 12-hour tag deployment schedule was kept from 0800 to 2000 hours. A 24-hour tagging day was designated as 0800 to 0800 hours the following day. The sampling crew checked the live box at each wheel in approximate 4 hour intervals (0730, 1200, 1600, and 1930 hours) or more often depending on catch rates. Using a dip net, chum in the live box were individually transferred to a sampling tub. Fish were tagged with a 30 cm, hollow core, individually numbered spaghetti tag (Floy Tag and Manufacturing Inc., Seattle, WA)[1] inserted with a 16 cm applicator needle into the musculature behind the dorsal fin and secured with an overhand knot. The adipose fin was removed as a secondary mark. Data recorded were: length (10 fish per day per tag site), measured from mideye to tail fork to the nearest 5 cm; sex; condition, determined by external physical aberrations judged as having the potential to affect survival or migration; and exterior color, graded by light or dark and used as an indicator of maturity. Because of the possible effect on the abundance estimate, chum considered to have severe wounds (bleeding, gashes, head injuries, fungus, etc.) were not tagged. Fish caught between 0800 and 2000 hours were categorized as day fish, while fish caught between 2000 and 0800 hours, tagged in the morning and held in the live box for up to 12 hours, were classified as night fish. Handling time per fish during tagging procedures was approximately 2 minutes. All Chinook salmon *O. tshawytscha* and coho salmon *O. kisutch* were enumerated by sex and released, while other species were identified, tallied, and released.

[1] Product names used in this report are included for scientific completeness, but do not constitute a product endorsement.

Because of the time required for tag deployment, a maximum of 150 fish were tagged at each site per day.

TAG RECOVERY

In the Tanana River, a tag recovery wheel operated by a contracted fisherman was located roughly 73 km upstream of the tag deployment site and downstream of the Nenana River (Figure 2). At this site, tagged and untagged salmon and other species were tallied using a digital video system. Fish captured by the fish wheel were counted when they exited the fish wheel baskets and were directed though a plastic chute designed to pass fish within the view of a camera (Borba *In prep*). Inseason data was summarized by the contract fisherman using software provided by ADF&G.

In the Kantishna River drainage, tags were recovered at 2 locations each with 2 fish wheels. One in the Toklat River, 89 km upstream and the other in the upper Kantishna River, 148 km upstream. At each site, tag number and color were recorded, coho salmon were counted by sex, and all other species were tallied.

To monitor wheel efficiency, wheel revolutions were recorded daily at the tag deployment fish wheels and the Toklat River tag recovery fish wheels. In addition, weather, water velocity, and water level were recorded once a day. Water temperature data was collected using Hobo (Onset Inc.) data loggers at the Tanana and Kantishna tag deployment wheel sites, at the Toklat and Tanana recovery wheel sites, and at the spawning grounds on the Toklat River. Tagging data were recorded in the field using an Allegro CE handheld field computer and downloaded daily into an Access database. A data summary for the previous 24-hour tagging day was reported daily to the ADF&G Fairbanks office via cellular or satellite telephone.

DATA ANALYSIS

Mark–recapture Assumption Tests

To test the assumption that tagged fish have equal chance of capture as untagged and are mixed in the population a series of statistical tests were performed. The following assumptions were examined: 1) equal chance of capture between right and left banks, 2) equal chance of capture at the Toklat and upper Kantishna River sites, 3) equal chance of capture for sex and length, and 4) equal chance of capture between day and night fish (i.e., no holding effects). Chi square (χ^2) tests were used to test assumptions 1, 2, and 4. For assumption 3, a logistic regression was used in which probability of recapture was regressed with length and sex. Finally, χ^2 tests for marked ratio through time were used to examine if the marked ratio at recovery wheels varied for all fish and by sex.

Abundance Estimation

Daily inseason abundance estimates were provided to fishery managers when the coefficient of variance (CV) was less than 0.30. Inseason estimates were considered preliminary until postseason assumption tests were completed.

Chapman's estimate (equation 1) and variance (equation 2) were employed to estimate the total fall chum run size for the Tanana and Kantishna Rivers (Chapman 1954).

Chapman's estimation equation is calculated as:

$$\hat{N} = \frac{(C+1)(M+1)}{R+1} - 1 \quad (1)$$

The variance was approximated as:

$$V[\hat{N}] \cong \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)} \quad (2)$$

where:

$\hat{N}$ = Total run estimate.

C = The number of fish caught at the tag recovery wheels.

M = The number of fish tagged and released at the tag deployment wheels.

R = The number of tagged fish recaptured at the tag recovery wheels.

Migration Rate

The migration rate between the tagging and recovery fish wheels was calculated as:

$$\hat{M} = \frac{RD}{D} \quad (3)$$

where:

RD = Distance between the tagging wheel and recovery wheel(s).

D = Number of days travel time between the tag and recovery wheels.

To investigate migration rate differences between day and night fish and between genders, a Holm Sidak test (Glantz 2002) was used.

Stock Timing

Ground surveys were conducted by ADF&G employees on the Delta and Toklat rivers to count the number of live and dead chum and coho salmon. On the Delta River, 8 replicate surveys were conducted from 12 October through 2 December. On the Toklat River, one survey was conducted of the fall chum spawning area known as the Toklat Springs from 25 through 28 October. One ground survey was conducted (by ADF&G and USFWS employees) on 18 November (during peak spawning) at Bluff Cabin Slough on the Tanana River. When possible, tags were retrieved at these locations.

RESULTS

TAG DEPLOYMENT

Tag deployment wheels operated from 16 August until 27 September on the Tanana River and from 16 August to 25 September on the Kantishna River. Total fall chum catch at the Tanana River tag deployment wheel was 8,495 fish of which 5,403 were tagged. At the Kantishna River tag deployment wheel, 4,568 fall chum were captured of which 3,952 were tagged (Appendix A1–A2). The peak chum CPUE of 57.4 fish per hour occurred on 21 September at the Tanana River tag deployment wheel and 20 September (16.4 fish per hour) at the Kantishna River tag deployment wheel. Fishing hours were reduced on the Tanana and Kantishna River during high catch rates (Figure 3; Appendix A1–A2).

TAG RECOVERY

On the Tanana River, the recovery wheel began operation on 16 August and continued through 3 October. Total fall chum catch was 17,152, of which 275 were tagged (Appendix A3). On the Toklat River, recovery wheel operations began on 16 August and ended on 30 September. Total fall chum catch (both wheels combined) was 6,230 fish, of which 241 were tagged (Appendix A4). On the Upper Kantishna River, recovery wheels operated from 16 August and ended on 8 October. The total number of fall chum captured (both wheels combined) was 549 of which 20 were tagged (Appendix A5). Total numbers of tags recovered, including public tag recoveries, are listed in Table 1.

Coho salmon represented a substantial portion of total catch at all fish wheels. Like previous years, coho CPUE was greatest at the Tanana River tag recovery wheel (47 fish per hour) and occurred on 26 September (Appendix A6).

DATA ANALYSIS

Mark–recapture Assumption Tests

A significant difference was found in the marked ratio between left and right bank recovery wheels on the Toklat (χ^2 = 4.203**,** df =1, P = 0.040), but not between wheels on the upper Kantishna River (χ^2 = 1.071**,** df = 1, P = 0.301) or between tag recovery locations (χ^2 = 0.014**,** df = 1, P = 0.905). Because the marked ratio varied only between wheels on the Toklat River and not between tag recovery locations, all Kantishna and Toklat River recovery data were pooled.

Logistic regression analysis indicated no significant difference in probability of recapture at recovery wheels due to length (Wald χ^2 = 0.864, df = 1, P = 0.353) or sex (Wald χ^2 = 0.383, df = 1, P = 0.536) (Table 2). The logistic regression test for holding affects using all tag and recovery data, indicated no significant difference in marked ratio in sex (Wald χ^2 = 0.736, df = 1, P = 0.391) or between day versus night fish (Wald χ^2 = 2.244, df = 1, P = 0.134) (Table 2).

Chi square tests for marked ratio through time at recovery sites on the Toklat and upper Kantishna River indicated a significant difference for all fish (χ^2 = 11.920**,** df = 6, P = 0.036) and females (χ^2 = 9.289**,** df = 5, P = 0.054) but not for males (χ^2 = 7.897**,** df = 6, P = 0.162).

The Tanana River tag recovery site chi square test for variation in marked ratio over time indicated a significant difference for all fish (χ^2 = 29.928**,** df = 5, P = <0.001) and females (χ^2 = 22.719**,** df = 4, P = <0.001) and males (χ^2 = 14.144**,** df = 5, P = 0.015)(Tables 2 and 3).

Abundance Estimate

The Tanana River inseason estimate (Table 4) was generated using Chapman's model; however, Chi square tests indicated a significant difference in the marked proportion over time. Accordingly, postseason tag color stratification was used for a Darroch model abundance estimate. The final abundance estimate for fall chum salmon was 337,755 (SE 22,166) for the Tanana River (Table 4; Figure 4).

The Kantishna River inseason estimate was also generated using Chapman's model. However, like the Tanana River the marked ratio changed over time (Table 5; Figure 4). As a result, the Darroch model estimator was calculated using Stratified Population Analysis System (SPAS) software. The final estimate for the Kantishna River was 107,719 (SE 7,649) (Table 6). The standard error of the Kantishna estimate was insignificant compared to previous years because

considerably more fish were examined at recovery wheels than tags deployed from the Kantishna River tag deployment wheel (Appendix A2–A5).

Migration Rate

Toklat River fall chum average migration rates were 20 km/day for day tagged fish (n = 128) and 16 km/day for night tagged fish (n = 108). Migration rate averages for tagged chum salmon captured at the upper Kantishna River tag recovery wheel were 24 km/day (n = 12) for day tagged fish and 23 km/day (n = 8) for night tagged fish. The Holm Sidak test indicated night fish migration rates were less than day fish migration rates ($F = 20.056$, $df = 1$, $P < 0.001$) and female migration rates were less than male ($F = 3.998$, $df = 1$, $P = 0.047$) (Tables 2 and 6).

Digital video is used to count fish at the Tanana tag recovery fish wheel. However, individual tag data was collected at this site during commercial fishing periods. Because most chum salmon tagged were day fish, only 10 night fish were recovered. Therefore, a Holm Sidak test was not used for these data. However, migration rates for all fish (day and night fish combined) were 29 km/day (n = 133) (Table 6).

Stock Timing

There were 120 tags recovered during foot surveys of the Toklat Springs and several from previous years of the project. The median tag deployment date for tags recovered at Toklat Springs was 9 September (date range of 24 August to 24 September), 3 September for tags recovered at the Toklat River fish wheels, (date range of 18 August to 24 September, N = 240) and 10 September for tags recovered at the upper Kantishna River fish wheels (date range of 21 August through 23 September, N = 20) (Table 1).

During foot surveys, 22 tags were recovered from spawning grounds in the Delta River between 3 October and 17 November 2005. The median tag deployment date for these fish was 19 September and tagging dates ranged from 22 August through 27 September (Table 1).

DISCUSSION

The 2005 Yukon drainage fall chum salmon run was the greatest on record and was documented by several run estimate and escapement projects. For example, the 2005 Pilot Station fall chum preliminary estimate of 1,812,824 fish is considerably greater than the 2000–2004 average of 486,962 (JTC 2006). An exceptionally strong 2005 fall chum run was documented in the Yukon drainage by the Chandalar River sonar project where the preliminary estimate is 496,484 fall chum while the 1995–2004 is 147,109 fish, (JTC 2006) and the Sheenjek River right bank sonar estimate of approximately 267,000[2] (1981–2004 mean = 82,000) (R. Dunbar, Commercial Fisheries Biologist, ADF&G, Fairbanks; personal communication). In addition, Delta River (Tanana drainage) escapement estimate of approximately 28,000 fall chum is well above the biological escapement goal (BEG) of 6,000 to 13,000 (B. Borba, Commercial Fisheries Biologist, ADF&G, Fairbanks; personal communication).

[2] The total estimate for 2005 was approximately 438,000 chum salmon. In previous years of the project, fish were counted on the right bank only. Fall chum were counted on both banks in 2005. Approximately 39% of the total 2005 count was from the left bank.

Correspondingly, the 2005 Tanana River mark–recapture run strength estimate is the highest on record since the beginning of the project and far exceeded the 1995–2004 mean estimate of 119,291 fall chum, and was well above the fall chum BEG of 61,000 to 136,000. The BEG is based on the Tanana River recapture estimate and the Toklat River escapement estimate (Eggers 2001) (Table 7). This estimate is almost certainly conservative due to reduced fishing hours for most of the season at the Tanana tag deployment wheel. In addition, high water in September due to heavy rain likely reduced catch rates through decreased fish wheel efficiency.

Migration rates of all tagged fall chum recaptured in the Tanana and Toklat River were less than average. Night fish migration rates for fish tagged in the Kantishna River were also less than day fish averages (Table 6). This is further evidence that holding fish in live boxes can affect migration rates, at least in years of high live box densities. However, decreased migration rate can be associated with high water (Cleary and Hamazaki 2005). Water levels in the Toklat and Kantishna Rivers were exceptionally high for most of September in 2005 due to rain, and the Tanana River water level measured at Nenana was much greater than the 1987–2005 average (Figure 5). Water temperatures were also higher at all fish wheel sites than previous years (Appendix A7) which could also affect migration speed (Salinger and Anderson 2006).

The 2005 Kantishna River fall chum abundance estimate of 107,719 fall chum far exceeds the 1999–2004 average abundance estimate of 48,638 (Table 7; Figure 4). Despite a record return to the Kantishna River the abundance of fall chum salmon in the Toklat Springs index area (estimated using a migratory time density curve) was approximately 18,000 fish (B. Borba, Commercial Fisheries Biologist, ADF&G, Fairbanks; personal communication). As in previous years it is unclear why foot survey counts and subsequent expanded counts are low compared to the Kantishna drainage abundance estimate (Cleary and Hamazaki 2004, Cleary and Hamazaki 2005). However, this could be attributed to the timing of mid-October foot surveys and the short duration of the surveys (2-3 days) with respect to stock timing which may represent an incomplete assessment of the total spawning population.

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TABLES AND FIGURES

Table 1.–Tags recovered by location from fall chum salmon in the Tanana and Kantishna Rivers, 2005.

Recapture Location	Method	Number of Tags	Tag deployment dates	
			median	range
Bluff Cabin Slough	Foot survey	4	-	-
Delta River	Foot survey	22	9/19	8/22-9/27
Toklat Springs	Foot survey	120	9/09	8/24-9/24
Tanana River recovery wheel [a]	Fish wheel/digital video	270	9/09	8/20-9/27
Toklat River recovery [b]	Fish wheels	240	9/03	8/18-9/24
Kantishna River recovery [c]	Fish wheels	20	9/10	8/21-9/23
Other tag recoveries [d]	Fishermen/public	388	-	-
Total		1,064		

[a] Tag data is from tags recovered during commercial periods.

[b] Includes only single recaptures.

[c] Includes tags captured after 10/1 not used in the abundance estimate.

[d] Combined tag recoveries from the Tanana and Kantishna tag deployment wheels.

Table 2.–Statistical test results for fall chum salmon captured in the Toklat, upper Kantishna, and Tanana River tag recovery fish wheels, 2005.

Logistic Regression tests

Location	Description	Wald Chi Square		df	P-Value		N
		Sex	Length		Sex	Length	
Toklat and upper Kantishna River	recapture probability based on sex and length	0.383	0.864	1	0.536	0.353	398
		Sex	Day vs. Night		Sex	Day vs. Night	
Toklat and upper Kantishna River	recapture probability based on sex and day vs. night	0.736	2.244	1	0.391	0.134	3,952

Holm Sidak Test		F		df	P-Value		N
		Sex	Day vs. Night		Sex	Day vs. Night	
Toklat and upper Kantishna River	migration rate based on sex and day vs. night	3.998	20.056	1	0.047	<0.001	256

Chi Square tests

Location	Description	Chi Square	df	P-Value
Toklat and upper Kantishna River	marked ratio between recovery locations	0.014	1	0.905
Toklat River	marked ratio between wheels	4.203	1	0.040
upper Kantishna River	marked ratio between wheels	1.071	1	0.301
Toklat and upper Kantishna River	marked ratio over time - all fish	11.920	6	0.036
Toklat and upper Kantishna River	marked ratio over time - males	7.897	6	0.162
Toklat and upper Kantishna River	marked ratio over time - females	9.289	5	0.054
Tanana River	marked ratio over time - all fish	29.928	5	<0.001
Tanana River	marked ratio over time - males	14.144	5	0.015
Tanana River	marked ratio over time - females	22.719	4	<0.001

Table 3.–Chi square test data and strata for marked ratio through time for fall chum salmon captured at the Tanana, upper Kantishna, and Toklat River tag recovery fish wheels, 2005.

		Marked						Total catch					
Tag recovery locations	**Test**	**8/16-8/22**	**8/23-8/29**	**8/30-9/5**	**9/6-9/12**	**9/13-9/19**	**9/20-9/30**	**8/16-8/22**	**8/23-8/29**	**8/30-9/5**	**9/6-9/12**	**9/13-9/19**	**9/20-9/30**
Toklat and upper Kantishna River	marked ratio over time (all fish)	1	9	64	54	67	62	65	143	1,317	1,688	1,498	1,965
Toklat and upper Kantishna River	marked ratio over time (males)	1	6	52	40	32	31	40	97	830	960	722	867
Toklat and upper Kantishna River	marked ratio over time (females)	0	3	12	14	35	31	25	46	487	728	776	1,097
Tanana River	marked ratio over time (all fish)	2	29	51	73	51	59	136	873	4,040	3,209	3,409	4,607

Table 4.–Inseason daily and cumulative catch and abundance estimates of fall chum salmon in the Tanana River, 2005.

Date	Released [a]	Examined For Tags	Recaptures [b]	Abundance [c]	95% Confidence Bounds Lower	95% Confidence Bounds Upper	Standard Error	CV
8/16	3	23	0					
8/17	52	40	0					
8/18	72	68	0					
8/19	112	82	0					
8/20	163	103	1					
8/21	258	117	1					
8/22	365	136	2					
8/23	476	180	3					
8/24	607	215	5					
8/25	750	247	5					
8/26	890	281	7					
8/27	1,032	422	13					
8/28	1,174	642	21					
8/29	1,317	1,009	31					
8/30	1,459	1,521	37	58,437	40,327	76,547	9,240	0.16
8/31	1,579	2,135	41	80,303	56,538	104,068	12,125	0.15
9/01	1,721	2,727	44	104,331	74,431	134,231	15,255	0.15
9/02	1,864	3,294	51	118,113	86,566	149,660	16,096	0.14
9/03	2,005	3,812	61	123,308	93,107	153,509	15,408	0.12
9/04	2,146	4,555	73	132,124	102,465	161,783	15,132	0.11
9/05	2,316	5,049	82	140,913	111,027	170,799	15,248	0.11
9/06	2,433	5,740	95	145,498	116,786	174,210	14,649	0.10
9/07	2,567	6,144	98	159,336	128,359	190,313	15,805	0.10
9/08	2,710	6,631	113	157,655	129,089	186,221	14,575	0.09
9/09	2,853	7,109	119	169,040	139,175	198,905	15,237	0.09
9/10	2,994	7,477	129	172,224	142,989	201,459	14,916	0.09
9/11	3,137	7,848	140	174,626	146,163	203,089	14,522	0.08
9/12	3,279	8,258	155	173,598	146,701	200,495	13,723	0.08
9/13	3,422	8,803	167	179,329	152,551	206,107	13,662	0.08
9/14	3,566	9,168	176	184,727	157,852	211,602	13,712	0.07
9/15	3,709	9,647	182	195,543	167,558	223,528	14,278	0.07
9/16	3,851	10,152	188	206,874	177,733	236,015	14,868	0.07
9/17	3,994	10,629	194	217,724	187,523	247,925	15,408	0.07
9/18	4,135	11,104	199	229,596	198,142	261,050	16,048	0.07
9/19	4,278	11,667	206	241,139	208,660	273,618	16,571	0.07
9/20	4,420	12,533	219	251,819	218,911	284,727	16,790	0.07
9/21	4,563	13,096	227	262,112	228,460	295,764	17,169	0.07
9/22	4,705	13,729	238	270,291	236,393	304,189	17,295	0.06
9/23	4,705	14,422	246	274,738	240,838	308,638	17,296	0.06
9/24	4,705	14,767	252	274,638	241,153	308,123	17,084	0.06
9/25	4,848	15,069	253	287,635	252,629	322,641	17,860	0.06
9/26	4,990	15,358	253	301,738	265,010	338,466	18,739	0.06
9/27	5,133	15,576	253	314,790	276,469	353,111	19,552	0.06
9/28	5,133	15,780	255	316,421	278,050	354,792	19,577	0.06
9/29	5,133	16,062	262	313,503	275,996	351,010	19,136	0.06
9/30	5,133	16,274	265	314,059	276,697	351,421	19,062	0.06

[a] The number of tags deployed was adjusted by 5% for mortality.

[b] Does not include tags recovered more than 3 days (average travel time) after tag deployment ended.

[c] This is an inseason estimate from edited data - not the final abundance estimate. Estimates were generated using the Darroch model.

Table 5.–Inseason daily and cumulative catch and abundance estimates of fall chum salmon in the Kantishna River, 2005.

Date	Released [a]	Examined For Tags	Recaptures [b]	Abundance [c]	95% Confidence Bounds Lower	95% Confidence Bounds Upper	Standard Error	CV
8/16	0	5	0					
8/17	12	9	0					
8/18	14	27	0					
8/19	32	35	0					
8/20	42	45	0					
8/21	51	51	0					
8/22	72	65	1					
8/23	85	71	2					
8/24	113	83	2					
8/25	150	104	3					
8/26	208	114	3					
8/27	276	130	5					
8/28	387	160	7					
8/29	512	208	10					
8/30	661	274	15					
8/31	794	361	17					
9/01	915	415	19	18,075	10,532	25,618	3,848	0.21
9/02	1,059	498	21	22,818	13,700	31,936	4,652	0.20
9/03	1,207	726	30	26,899	17,780	36,018	4,653	0.17
9/04	1,309	1,082	47	28,068	20,385	35,751	3,920	0.14
9/05	1,431	1,525	74	27,651	21,589	33,713	3,093	0.11
9/06	1,522	2,083	95	31,390	25,289	37,491	3,113	0.10
9/07	1,613	2,608	112	35,372	29,021	41,723	3,240	0.09
9/08	1,763	2,757	113	40,523	33,271	47,775	3,700	0.09
9/09	1,823	2,827	118	41,160	33,952	48,368	3,678	0.09
9/10	1,943	2,946	122	44,229	36,608	51,850	3,888	0.09
9/11	2,054	3,108	124	48,525	40,224	56,826	4,235	0.09
9/12	2,155	3,213	128	51,000	42,411	59,589	4,382	0.09
9/13	2,259	3,339	131	54,300	45,256	63,344	4,614	0.08
9/14	2,382	3,490	134	58,520	48,877	68,163	4,920	0.08
9/15	2,516	3,621	142	60,536	50,846	70,226	4,944	0.08
9/16	2,666	3,823	150	64,147	54,152	74,142	5,099	0.08
9/17	2,814	4,148	171	64,478	55,071	73,885	4,800	0.07
9/18	2,926	4,410	186	65,575	56,402	74,748	4,680	0.07
9/19	3,076	4,711	195	70,247	60,644	79,850	4,900	0.07
9/20	3,223	4,809	198	74,011	63,968	84,054	5,124	0.07
9/21	3,372	4,888	202	77,140	66,776	87,504	5,288	0.07
9/22	3,522	5,082	211	80,225	69,678	90,772	5,381	0.07
9/23	3,659	5,358	221	83,909	73,126	94,692	5,501	0.07
9/24	3,800	5,589	228	88,122	76,969	99,275	5,690	0.06
9/25	3,952	5,708	230	92,777	81,082	104,472	5,967	0.06
9/26	3,952	5,931	238	93,175	81,627	104,723	5,892	0.06
9/27	3,952	6,200	249	93,114	81,829	104,399	5,758	0.06
9/28	3,952	6,402	252	95,007	83,556	106,458	5,842	0.06
9/29	3,952	6,562	256	95,866	84,399	107,333	5,850	0.06
9/30	3,952	6,675	257	97,138	85,539	108,737	5,918	0.06
10/01	3,952	6,712	258	97,300	85,703	108,897	5,917	0.06

[a] The number of tags deployed was adjusted by 5% for mortality.

[b] Does not include tags recovered more than 6 days (average travel time) after tag deployment ended.

[c] This is an inseason estimate from edited data - not the final abundance estimate. Estimates were generated using the Darroch model.

Table 6.–Estimated migration rates (km/day) for day and night caught fall chum salmon in the Tanana and Kantishna Rivers, 1995–2005.

Tanana River tagging fish wheel to Tanana River recovery fish wheel (73 km)

Year	Day km/day	n	Night km/day	n	Combined km/day	Total - n
1995 [a]	-	-	-	-	26	166
1996 [a]	-	-	-	-	31	187
1997 [a]	-	-	-	-	21	104
1998	29	49	31	30	30	79
1999	29	8	16	14	23	22
2000	25	25	20	20	23	45
2001	24	10	49	7	37	17
2002	28	22	29	47	29	69
2003	27	21	21	13	24	34
2004	-		-			
2005	29	123	19	10	24	133 [b]
1995–2004 mean	27	23	28	22	27	80

Kantishna River tag deployment wheel to the Toklat River tag recovery wheels (89 km)

Year	Day km/day	n	Night km/day	n	Combined km/day	Total - n
1999	20	26	22	28	21	54
2000	25	24	29	9	27	33
2001	25	52	28	37	27	89
2002	24	84	27	81	26	165
2003	16	54	15	31	16	85
2004	19	151	16	179	17	330
2005	20	128	16	108	18	236
1999–2004 mean	22	65	23	61	22	126

Kantishna River tag deployment wheel to the Kantishna River tag recovery wheels (148 km)

Year	Day km/day	n	Night km/day	n	Combined km/day	Total - n
2000	26	10	27	1	27	11
2001	31	2	28	3	30	5
2002	21	10	21	4	21	14
2003	16	22	15	4	16	26
2004	16	7	14	12	15	19
2005	24	12	23	8	23	20
2000–2004 mean	22	10	21	5	22	15

[a] Migration estimated for all fish only.

[b] Tag numbers from commercial harvest - not the total number of tags viewed on video.

Table 7.–Tanana and Kantishna Rivers fall chum salmon abundance estimates, 1995–2005.

Tanana River

Year	Point Estimate	SE	95% Lower Bound	95% Upper bound
1995	268,173	21,597	225,842	310,503
1996	134,563	16,945	101,351	167,775
1997	71,661	11,876	48,384	94,937
1998	62,014	6,556	49,164	74,863
1999	97,843	19,362	59,893	135,792
2000	34,844	4,970	25,104	44,584
2001	96,556	20,955	55,484	137,627
2002	109,961	12,724	85,022	134,900
2003	193,418	9,976	173,866	212,970
2004	123,879	11,071	102,179	145,579
2005	337,755	22,166	294,309	381,202
1995–2004 Mean	119,291			

Kantishna River

Year	Point Estimate	SE	95% Lower Bound	95% Upper bound
1999	27,199	3,562	20,218	34,180
2000	21,450	3,031	15,510	27,390
2001	22,992	2,172	18,734	27,250
2002	56,665	4,122	48,587	64,743
2003	87,359	8,041	71,600	103,118
2004	76,163	4,391	67,557	84,769
2005	107,719	7,649	92,726	122,712
1999–2004 Mean	48,638			

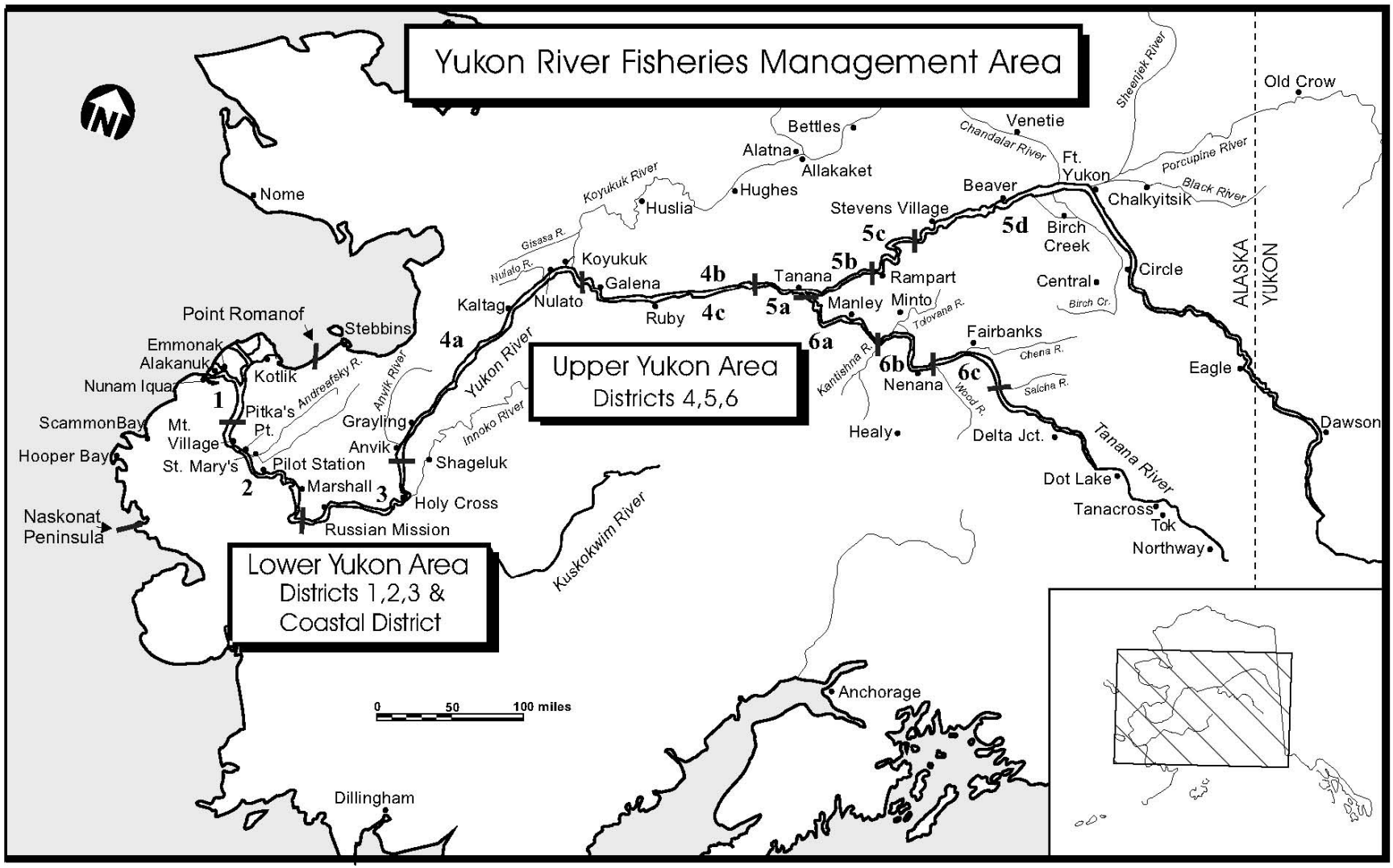


Figure 1.–Fishery management districts and sub-districts in the Yukon and Tanana River drainages.

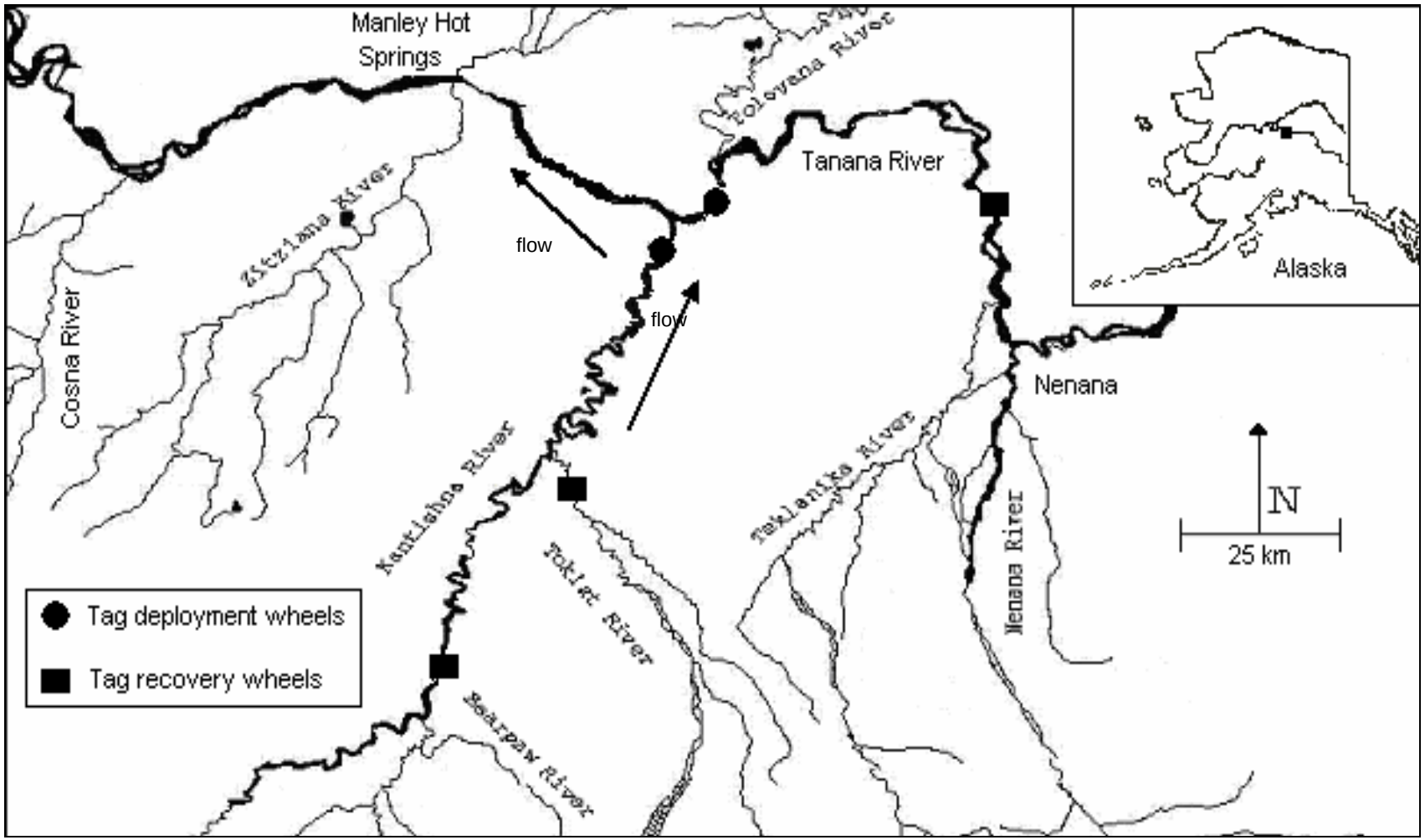


Figure 2.–Location of tag deployment and recovery wheels used in the Tanana and Kantishna River fall chum salmon mark–recapture project.

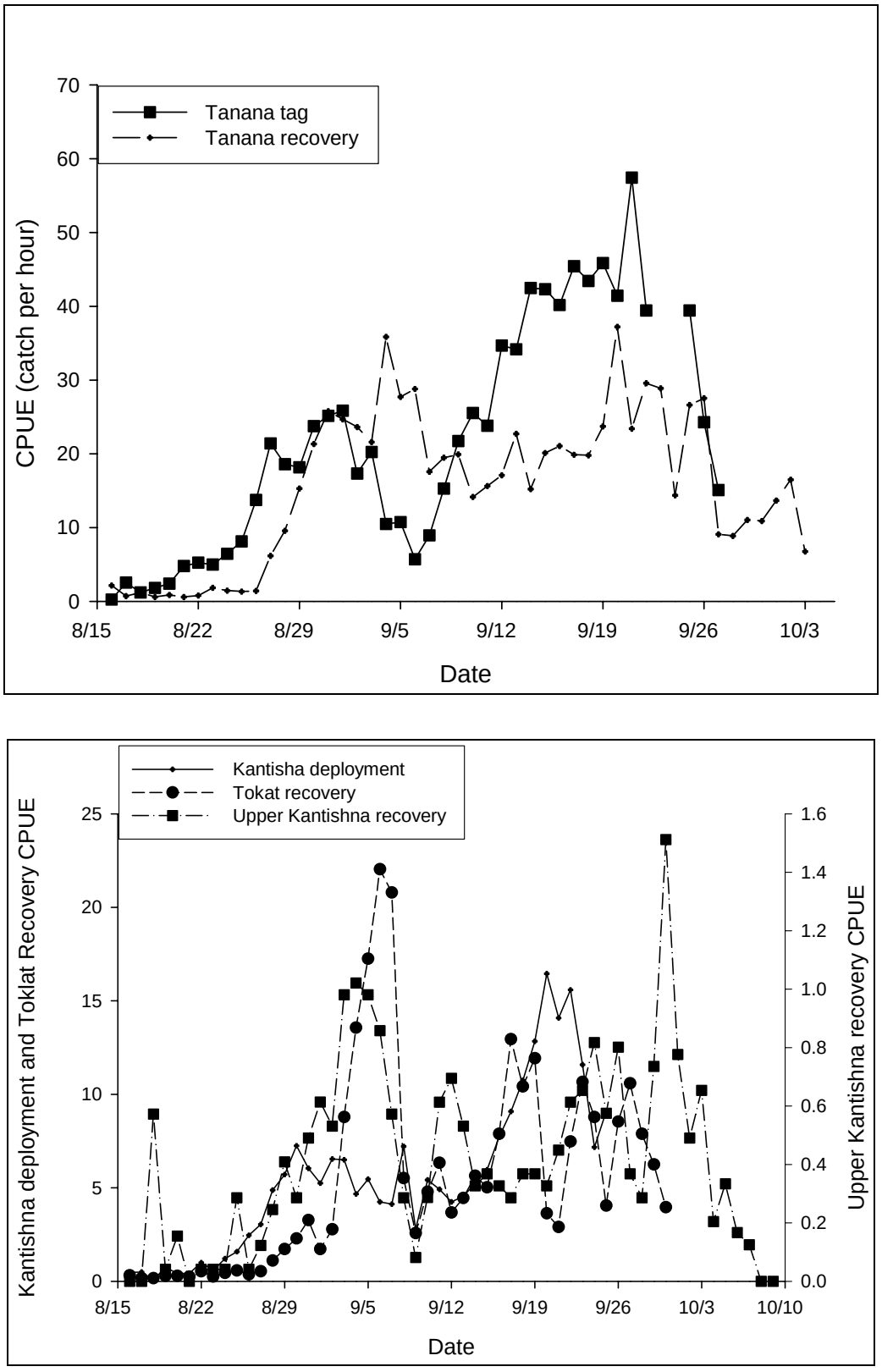
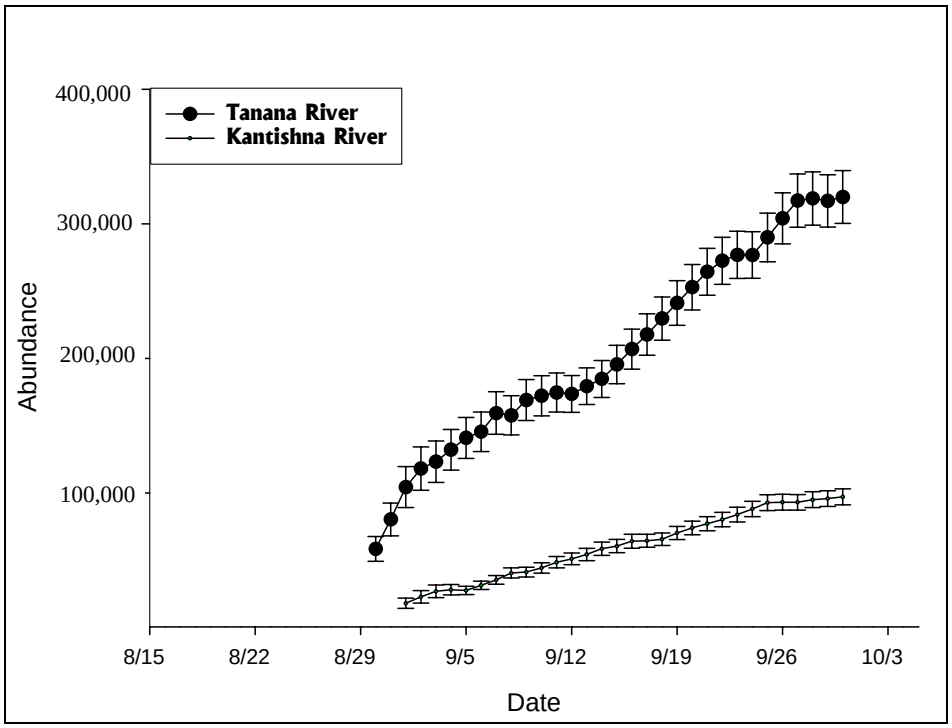


Figure 3.–Daily fall chum salmon CPUE at the Tanana River tagging and recovery fish wheels (top), and CPUE at the Kantishna River tag deployment wheel and recovery fish wheels on the Toklat and upper Kantishna Rivers (bottom), 2005.



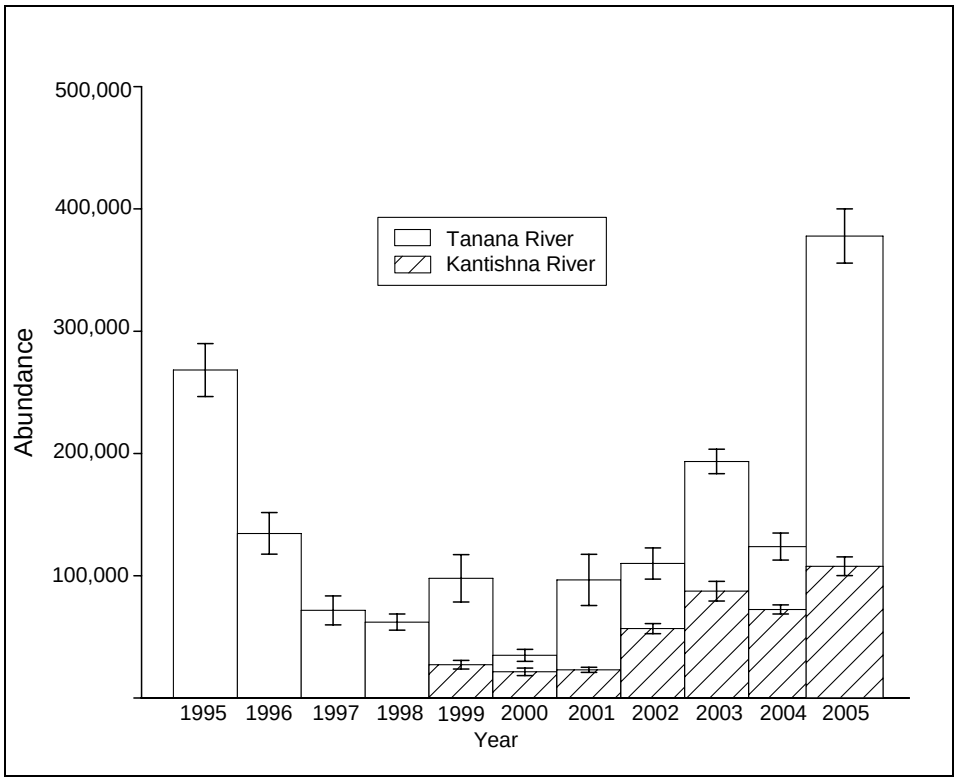


Figure 4.–Fall chum salmon inseason abundance estimates (±SE for estimates with a CV < 0.30) for the Tanana and Kantishna Rivers, 2005 (top) and abundance estimates for the Tanana River, 1995–2005 and Kantishna River, 1999–2005 (bottom).

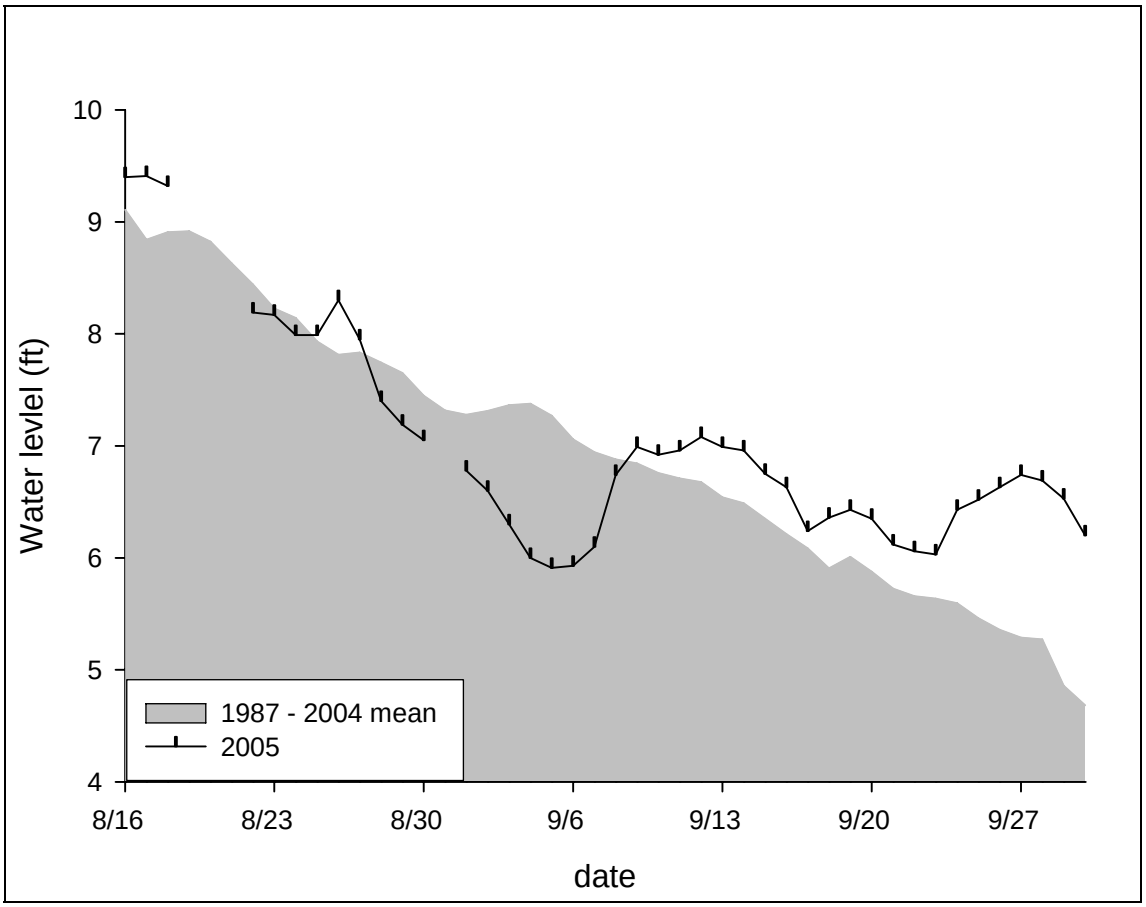


Figure 5.–Tanana River water levels as measured by a U.S. Geological Survey gauge located near Nenana.

APPENDIX A

Appendix A1.–Daily effort and catch of fall chum salmon at the Tanana River tag deployment fish wheel, 2005.

	Tagged						Not Tagged					Total					
Date	Hours Fished	No. Male	No. Female	UNK [a] Sex	Total	Cum.	No. Male	No. Female	UNK [a] Sex	Total	Cum.	No. Male	No. Female	UNK [a] Sex	Total	Cum.	Catch Per Hour
8/16	12	2	1	0	3	3	0	0	0	0	0	2	1	0	3	3	0.3
8/17	24	23	29	0	52	55	2	7	0	9	9	25	36	0	61	64	2.5
8/18	24	11	10	0	21	76	2	6	0	8	17	13	16	0	29	93	1.2
8/19	24	24	18	0	42	118	2	0	0	2	19	26	18	0	44	137	1.8
8/20	24	25	29	0	54	172	2	2	0	4	23	27	31	0	58	195	2.4
8/21	24	53	47	0	100	272	5	8	2	15	38	58	55	2	115	310	4.8
8/22	24	50	62	0	112	384	0	14	0	14	52	50	76	0	126	436	5.3
8/23	24	63	54	0	117	501	2	1	0	3	55	65	55	0	120	556	5.0
8/24	24	70	68	0	138	639	4	13	0	17	72	74	81	0	155	711	6.5
8/25	24	86	64	0	150	789	20	24	1	45	117	106	88	1	195	906	8.1
8/26	24	83	65	0	148	937	90	92	0	182	299	173	157	0	330	1,236	13.8
8/27	12	89	60	0	149	1,086	52	55	1	108	407	141	115	1	257	1,493	21.4
8/28	12	109	41	0	150	1,236	42	31	0	73	480	151	72	0	223	1,716	18.6
8/29	12	99	51	0	150	1,386	30	38	0	68	548	129	89	0	218	1,934	18.2
8/30	8	116	34	0	150	1,536	25	15	0	40	588	141	49	0	190	2,124	23.8
8/31	7	86	40	0	126	1,662	19	31	0	50	638	105	71	0	176	2,300	25.1
9/01	7	111	39	0	150	1,812	22	9	0	31	669	133	48	0	181	2,481	25.9
9/02	9	120	30	0	150	1,962	6	0	0	6	675	126	30	0	156	2,637	17.3
9/03	8	107	41	0	148	2,110	12	2	0	14	689	119	43	0	162	2,799	20.3
9/04	24	111	38	0	149	2,259	66	37	0	103	792	177	75	0	252	3,051	10.5
9/05	24	139	40	0	179	2,438	41	37	1	79	871	180	77	1	258	3,309	10.8
9/06	24	100	23	0	123	2,561	7	7	0	14	885	107	30	0	137	3,446	5.7
9/07	24	90	51	0	141	2,702	43	31	0	74	959	133	82	0	215	3,661	9.0
9/08	24	102	49	0	151	2,853	132	84	0	216	1,175	234	133	0	367	4,028	15.3
9/09	7.5	98	52	0	150	3,003	6	7	0	13	1,188	104	59	0	163	4,191	21.7
9/10	6.5	97	52	0	149	3,152	7	10	0	17	1,205	104	62	0	166	4,357	25.5
9/11	7.6	100	50	0	150	3,302	17	14	0	31	1,236	117	64	0	181	4,538	23.8
9/12	7.5	98	52	0	150	3,452	48	62	0	110	1,346	146	114	0	260	4,798	34.7
9/13	7.9	88	62	0	150	3,602	67	53	0	120	1,466	155	115	0	270	5,068	34.2
9/14	7.3	111	41	0	152	3,754	79	79	0	158	1,624	190	120	0	310	5,378	42.5

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Appendix A1.–Page 2 of 2.

	Tagged						Not Tagged					Total					
Date	Hours Fished	No. Male	No. Female	UNK [a] Sex	Total	Cum.	No. Male	No. Female	UNK [a] Sex	Total	Cum.	No. Male	No. Female	UNK [a] Sex	Total	Cum.	Catch Per Hour
9/15	8	108	42	0	150	3,904	89	91	0	180	1,804	197	133	0	330	5,708	42.3
9/16	6	96	54	0	150	4,054	47	52	0	99	1,903	143	106	0	249	5,957	40.2
9/17	7	98	52	0	150	4,204	84	84	0	168	2,071	182	136	0	318	6,275	45.4
9/18	7	93	56	0	149	4,353	82	73	0	155	2,226	175	129	0	304	6,579	43.4
9/19	7	102	48	0	150	4,503	75	96	0	171	2,397	177	144	0	321	6,900	45.9
9/20	7	87	63	0	150	4,653	69	71	0	140	2,537	156	134	0	290	7,190	41.4
9/21	7	84	66	0	150	4,803	119	133	0	252	2,789	203	199	0	402	7,592	57.4
9/22	7	83	67	0	150	4,953	50	76	0	126	2,915	133	143	0	276	7,868	39.4
9/23	0				0	4,953					2,915					7,868	0.0
9/24	0				0	4,953					2,915					7,868	0.0
9/25	7	55	95	0	150	5,103	43	83	0	126	3,041	98	178	0	276	8,144	39.4
9/26	7	46	104	0	150	5,253	6	14	0	20	3,061	52	118	0	170	8,314	24.3
9/27	12	56	94	0	150	5,403	9	22	0	31	3,092	65	116	0	181	8,495	15.1
Total	573.3	3,369	2,034	0	5,403		1,523	1,564	5	3,092		4,892	3,598	5	8,495		

Note: Does not include recaptures or other data omitted before the final abundance estimate.

[a] Unidentified sex.

Appendix A2.–Daily effort and catch of fall chum salmon at the Kantishna River tag deployment fish wheel, 2005.

		Tagged					Not Tagged					Total					
Date	Hours Fished	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Catch Per Hour
8/16	15	0	0	0	0	0	6	1	0	7	7	6	1	0	7	7	0.5
8/17	24	5	7	0	12	12	0	0	0	0	7	5	7	0	12	19	0.5
8/18	24	2	0	0	2	14	0	0	0	0	7	2	0	0	2	21	0.1
8/19	24	13	5	0	18	32	0	0	0	0	7	13	5	0	18	39	0.8
8/20	24	8	2	0	10	42	0	0	0	0	7	8	2	0	10	49	0.4
8/21	24	7	2	0	9	51	1	0	0	1	8	8	2	0	10	59	0.4
8/22	24	12	9	0	21	72	2	0	1	3	11	14	9	1	24	83	1.0
8/23	24	10	3	0	13	85	0	1	0	1	12	10	4	0	14	97	0.6
8/24	24	20	8	0	28	113	0	1	0	1	13	20	9	0	29	126	1.2
8/25	24	27	10	0	37	150	1	0	0	1	14	28	10	0	38	164	1.6
8/26	24	39	19	0	58	208	1	0	0	1	15	40	19	0	59	223	2.5
8/27	24	52	16	0	68	276	4	1	0	5	20	56	17	0	73	296	3.0
8/28	24	79	32	0	111	387	5	1	0	6	26	84	33	0	117	413	4.9
8/29	24	87	38	0	125	512	7	5	0	12	38	94	43	0	137	550	5.7
8/30	24	108	41	0	149	661	17	8	0	25	63	125	49	0	174	724	7.3
8/31	24	98	35	0	133	794	11	1	0	12	75	109	36	0	145	869	6.0
9/01	24	84	37	0	121	915	4	0	1	5	80	88	37	1	126	995	5.3
9/02	24	100	44	0	144	1,059	8	5	0	13	93	108	49	0	157	1,152	6.5
9/03	24	116	32	0	148	1,207	5	3	0	8	101	121	35	0	156	1,308	6.5
9/04	24	74	28	0	102	1,309	7	3	0	10	111	81	31	0	112	1,420	4.7
9/05	24	83	39	0	122	1,431	5	4	0	9	120	88	43	0	131	1,551	5.5
9/06	24	68	23	0	91	1,522	5	3	3	11	131	73	26	3	102	1,653	4.3
9/07	24	64	27	0	91	1,613	3	5	0	8	139	67	32	0	99	1,752	4.1
9/08	24	107	43	0	150	1,763	13	10	0	23	162	120	53	0	173	1,925	7.2
9/09	24	35	25	0	60	1,823	4	3	0	7	169	39	28	0	67	1,992	2.8
9/10	24	81	39	0	120	1,943	3	5	2	10	179	84	44	2	130	2,122	5.4
9/11	24	63	48	0	111	2,054	4	3	0	7	186	67	51	0	118	2,240	4.9
9/12	24	58	43	0	101	2,155	0	1	0	1	187	58	44	0	102	2,342	4.3
9/13	24	48	56	0	104	2,259	3	2	0	5	192	51	58	0	109	2,451	4.5
9/14	24	67	56	0	123	2,382	2	1	0	3	195	69	57	0	126	2,577	5.3
9/15	24	77	57	0	134	2,516	2	7	0	9	204	79	64	0	143	2,720	6.0

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Appendix A2.–Page 2 of 2.

	Tagged						Not Tagged					Total					
Date	Hours Fished	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Catch Per Hour
9/16	24	86	64	0	150	2,666	18	17	0	35	239	104	81	0	185	2,905	7.7
9/17	24	91	57	0	148	2,814	43	27	0	70	309	134	84	0	218	3,123	9.1
9/18	24	70	42	0	112	2,926	69	77	0	146	455	139	119	0	258	3,381	10.8
9/19	12	82	68	0	150	3,076	3	1	0	4	459	85	69	0	154	3,535	12.8
9/20	9	78	69	0	147	3,223	0	1	0	1	460	78	70	0	148	3,683	16.4
9/21	12	75	74	0	149	3,372	9	10	1	20	480	84	84	1	169	3,852	14.1
9/22	12	78	72	0	150	3,522	15	22	0	37	517	93	94	0	187	4,039	15.6
9/23	12	68	69	0	137	3,659	1	1	0	2	519	69	70	0	139	4,178	11.6
9/24	24	62	79	0	141	3,800	11	20	0	31	550	73	99	0	172	4,350	7.2
9/25	24	73	79	0	152	3,952	32	34	0	66	616	105	113	0	218	4,568	9.1
Total	912	2,455	1,497	0	3,952		324	284	8	616		2,779	1,781	8	4,568		

Note: Does not include recaptures or other data omitted before the final abundance estimate.

[a] Unidentified sex.

Appendix A3.–Daily effort and catch of fall chum salmon at the Tanana River recovery fish wheel, 2005.

		Tagged					Not Tagged					Total					
Date	Hours Fished	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Catch Per Hour
8/16	11	0	0	0	0	0	8	15	0	23	23	8	15	0	23	23	2.2
8/17	24	0	0	0	0	0	11	6	0	17	40	11	6	0	17	40	0.7
8/18	24	0	0	0	0	0	11	17	0	28	68	11	17	0	28	68	1.2
8/19	24	0	0	0	0	0	7	7	0	14	82	7	7	0	14	82	0.6
8/20	24	0	1	0	1	1	12	8	0	20	102	12	9	0	21	103	0.9
8/21	24	0	0	0	0	1	6	8	0	14	116	6	8	0	14	117	0.6
8/22	24	1	0	0	1	2	7	11	0	18	134	8	11	0	19	136	0.8
8/23	24	0	1	0	1	3	12	31	0	43	177	12	32	0	44	180	1.8
8/24	24	2	0	0	2	5	14	19	0	33	210	16	19	0	35	215	1.5
8/25	24	0	0	0	0	5	17	15	0	32	242	17	15	0	32	247	1.3
8/26	24	0	2	0	2	7	18	14	0	32	274	18	16	0	34	281	1.4
8/27	23	1	5	0	6	13	68	67	0	135	409	69	72	0	141	422	6.2
8/28	23	4	4	0	8	21	106	106	0	212	621	110	110	0	220	642	9.6
8/29	24	5	5	0	10	31	184	173	0	357	978	189	178	0	367	1,009	15.3
8/30	24	3	3	0	6	37	273	233	0	506	1,484	276	236	0	512	1,521	21.3
8/31	24	3	1	0	4	41	330	280	0	610	2,094	333	281	0	614	2,135	25.8
9/01	24	1	2	0	3	44	326	263	0	589	2,683	327	265	0	592	2,727	24.7
9/02	24	3	4	0	7	51	312	248	0	560	3,243	315	252	0	567	3,294	23.6
9/03	24	8	2	0	10	61	291	217	0	508	3,751	299	219	0	518	3,812	21.6
9/04	21	7	5	0	12	73	418	313	0	731	4,482	425	318	0	743	4,555	35.8
9/05	18	6	3	0	9	82	304	181	0	485	4,967	310	184	0	494	5,049	27.7
9/06	24	10	3	0	13	95	421	257	0	678	5,645	431	260	0	691	5,740	28.8
9/07	23	3	0	0	3	98	254	147	0	401	6,046	257	147	0	404	6,144	17.6
9/08	25	11	4	0	15	113	266	206	0	472	6,518	277	210	0	487	6,631	19.5
9/09	24	5	1	0	6	119	273	199	0	472	6,990	278	200	0	478	7,109	19.9
9/10	26	10	0	0	10	129	209	149	0	358	7,348	219	149	0	368	7,477	14.2
9/11	24	7	4	0	11	140	218	142	0	360	7,708	225	146	0	371	7,848	15.6
9/12	24	9	6	0	15	155	226	169	0	395	8,103	235	175	0	410	8,258	17.1

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Appendix A3.–Page 2 of 2.

	Tagged						Not Tagged					Total					
Date	Hours Fished	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Catch Per Hour
9/13	24	7	5	0	12	167	304	229	0	533	8,636	311	234	0	545	8,803	22.7
9/14	24	4	5	0	9	176	204	152	0	356	8,992	208	157	0	365	9,168	15.2
9/15	24	4	2	0	6	182	246	227	0	473	9,465	250	229	0	479	9,647	20.1
9/16	24	4	2	0	6	188	256	243	0	499	9,964	260	245	0	505	10,152	21.0
9/17	24	5	1	0	6	194	244	227	0	471	10,435	249	228	0	477	10,629	19.9
9/18	24	3	2	0	5	199	230	240	0	470	10,905	233	242	0	475	11,104	19.8
9/19	24	5	2	0	7	206	272	284	0	556	11,461	277	286	0	563	11,667	23.7
9/20	23	8	5	0	13	219	388	465	0	853	12,314	396	469	0	865	12,532	37.2
9/21	24	6	2	0	8	227	274	281	0	555	12,869	280	282	0	562	13,094	23.4
9/22	21	6	5	0	11	238	307	315	0	622	13,491	313	320	0	633	13,727	29.6
9/23	24	4	4	0	8	246	286	399	0	685	14,176	290	403	0	693	14,420	28.9
9/24	24	3	3	0	6	252	135	204	0	339	14,515	138	207	0	345	14,765	14.4
9/25	11	0	1	0	1	253	124	177	0	301	14,816	124	178	0	302	15,067	26.6
9/26	11	0	0	0	0	253	130	159	0	289	15,105	130	159	0	289	15,356	27.5
9/27	24	0	0	0	0	253	95	123	0	218	15,323	95	123	0	218	15,574	9.1
9/28	23	2	0	0	2	255	80	122	0	202	15,525	82	122	0	204	15,778	0.0
9/29	25	5	2	0	7	262	100	174	0	274	15,799	103	177	0	280	16,058	11.0
9/30	19	2	1	0	3	265	94	115	0	209	16,008	95	115	0	210	16,268	10.9
10/1	26	3	4	0	7	272	102	242	0	344	16,352	105	246	0	351	16,619	13.7
10/2	24	1	2	0	3	275	127	266	0	393	16,745	128	268	0	396	17,015	16.5
10/3	20	0	0	0	0	275	53	84	0	137	16,882	53	84	0	137	17,152	6.7
Total	1,117	171	104	0	275		8,653	8,229	0	16,882		8,821	8,331	0	17,152		

Note: Does not include recaptures or undetermined tags from video counting.

[a] Unidentified sex.

Appendix A4.–Daily effort and catch of fall chum salmon at the Toklat River recovery fish wheels, (both combined), 2005.

		Tagged					Not Tagged					Total					
Date	Hours Fished	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Catch Per Hour
8/16	16	0	0	0	0	0	2	3	0	5	5	2	3	0	5	5	0.3
8/17	24	0	0	0	0	0	4	0	0	4	9	4	0	0	4	9	0.2
8/18	24	0	0	0	0	0	2	2	0	4	13	2	2	0	4	13	0.2
8/19	24	0	0	0	0	0	5	2	0	7	20	5	2	0	7	20	0.3
8/20	24	0	0	0	0	0	4	3	0	7	27	4	3	0	7	27	0.3
8/21	24	0	0	0	0	0	5	1	0	6	33	5	1	0	6	33	0.2
8/22	24	1	0	0	1	1	8	4	0	12	45	9	4	0	13	46	0.5
8/23	20	1	0	0	1	2	4	0	0	4	49	5	0	0	5	51	0.2
8/24	24	0	0	0	0	2	9	2	0	11	60	9	2	0	11	62	0.4
8/25	24	0	0	0	0	2	8	6	0	14	74	8	6	0	14	76	0.6
8/26	24	0	0	0	0	2	7	2	0	9	83	7	2	0	9	85	0.4
8/27	24	0	2	0	2	4	6	5	0	11	94	6	7	0	13	98	0.5
8/28	24	2	0	0	2	6	19	6	0	25	119	21	6	0	27	125	1.1
8/29	24	2	1	0	3	9	22	17	0	39	158	24	18	0	42	167	1.7
8/30	24	4	1	0	5	14	32	19	0	51	209	36	20	0	56	223	2.3
8/31	24	0	2	0	2	16	48	30	0	78	287	48	32	0	80	303	3.3
9/01	24	2	0	0	2	18	26	14	0	40	327	28	14	0	42	345	1.7
9/02	24	1	0	0	1	19	53	14	0	67	394	54	14	0	68	413	2.8
9/03	24	7	0	0	7	26	131	77	0	208	602	138	77	0	215	628	8.8
9/04	24	13	3	0	16	42	194	122	0	316	918	207	125	0	332	960	13.6
9/05	24	21	5	0	26	68	228	164	0	392	1,310	249	169	0	418	1,378	17.2
9/06	24	15	6	0	21	89	345	168	0	513	1,823	360	174	0	534	1,912	22.0
9/07	24	13	2	0	15	104	268	221	0	489	2,312	281	223	0	504	2,416	20.8
9/08	24	1	0	0	1	105	59	75	0	134	2,446	60	75	0	135	2,551	5.5
9/09	24	1	4	0	5	110	26	32	0	58	2,504	27	36	0	63	2,614	2.6
9/10	24	4	0	0	4	114	62	51	0	113	2,617	66	51	0	117	2,731	4.8
9/11	24	0	2	0	2	116	74	79	0	153	2,770	74	81	0	155	2,886	6.3
9/12	24	4	0	0	4	120	39	47	0	86	2,856	43	47	0	90	2,976	3.7

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Appendix A4.–Page 2 of 2.

		Tagged					Not Tagged					Total					
Date	Hours Fished	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Catch Per Hour
9/13	24	1	2	0	3	123	53	53	0	106	2,962	54	55	0	109	3,085	4.5
9/14	24	2	1	0	3	126	66	69	0	135	3,097	68	70	0	138	3,223	5.6
9/15	24	3	4	0	7	133	53	63	0	116	3,213	56	67	0	123	3,346	5.0
9/16	24	4	3	0	7	140	82	104	0	186	3,399	86	107	0	193	3,539	7.9
9/17	24	9	11	0	20	160	148	149	0	297	3,696	157	160	0	317	3,856	12.9
9/18	24	7	7	0	14	174	110	131	0	241	3,937	117	138	0	255	4,111	10.4
9/19	24	4	5	0	9	183	136	147	0	283	4,220	140	152	0	292	4,403	11.9
9/20	24	1	2	0	3	186	39	47	0	86	4,306	40	49	0	89	4,492	3.6
9/21	24	1	1	0	2	188	37	32	0	69	4,375	38	33	0	71	4,563	2.9
9/22	24	2	5	0	7	195	98	78	0	176	4,551	100	83	0	183	4,746	7.5
9/23	24	5	5	0	10	205	120	131	0	251	4,802	125	136	0	261	5,007	10.7
9/24	24	4	2	0	6	211	90	119	0	209	5,011	94	121	0	215	5,222	8.8
9/25	24	2	0	0	2	213	53	44	0	97	5,108	55	44	0	99	5,321	4.0
9/26	24	5	4	0	8	221	75	126	0	201	5,309	79	130	0	209	5,530	8.5
9/27	24	2	8	1	11	232	90	158	0	248	5,557	92	166	1	259	5,789	10.6
9/28	24	2	1	0	3	235	66	124	0	190	5,747	68	125	0	193	5,982	7.9
9/29	24	3	1	0	4	239	69	80	0	149	5,896	72	81	0	153	6,135	6.3
9/30	24	0	1	0	1	240	41	53	0	94	5,990	41	54	0	95	6,230	4.0
Total	1,112	149	91	1	241		3,116	2,874	0	5,990		3,264	2,965	1	6,230		

Note: Does not include tagged chum salmon captured more than once.

[a] Unidentified sex.

Appendix A5.–Daily effort and catch of fall chum salmon at the Kantishna River recovery fish wheels, (both combined), 2005.

	Tagged						Not Tagged					Total					
Date	Hours Fished	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Catch Per Hour
8/16	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
8/17	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
8/18	24	0	0	0	0	0	8	6	0	14	14	8	6	0	14	14	0.6
8/19	24	0	0	0	0	0	0	1	0	1	15	0	1	0	1	15	0.0
8/20	19	0	0	0	0	0	0	3	0	3	18	0	3	0	3	18	0.2
8/21	24	0	0	0	0	0	0	0	0	0	18	0	0	0	0	18	0.0
8/22	24	0	0	0	0	0	1	0	0	1	19	1	0	0	1	19	0.0
8/23	24	0	0	0	0	0	1	0	0	1	20	1	0	0	1	20	0.0
8/24	24	0	0	0	0	0	1	0	0	1	21	1	0	0	1	21	0.0
8/25	24	1	0	0	1	1	5	1	0	6	27	6	1	0	7	28	0.3
8/26	24	0	0	0	0	1	1	0	0	1	28	1	0	0	1	29	0.0
8/27	24	0	0	0	0	1	3	0	0	3	31	3	0	0	3	32	0.1
8/28	24	0	0	0	0	1	2	1	0	3	34	2	1	0	3	35	0.1
8/29	24	0	0	0	0	1	3	3	0	6	40	3	3	0	6	41	0.2
8/30	24	0	0	0	0	1	7	3	0	10	50	7	3	0	10	51	0.4
8/31	24	0	0	0	0	1	3	4	0	7	57	3	4	0	7	58	0.3
9/01	24	0	0	0	0	1	8	4	0	12	69	8	4	0	12	70	0.5
9/02	24	1	1	0	2	3	10	4	0	14	83	11	4	0	15	85	0.6
9/03	24	1	0	0	1	4	10	1	0	11	94	11	2	0	13	98	0.5
9/04	24	1	0	0	1	5	12	11	0	23	117	13	11	0	24	122	1.0
9/05	24	1	0	0	1	6	16	8	0	24	141	17	8	0	25	147	1.0
9/06	24	0	0	0	0	6	12	12	0	24	165	12	12	0	24	171	1.0
9/07	24	2	0	0	2	8	11	8	0	19	184	13	8	0	21	192	0.9
9/08	24	0	0	0	0	8	8	6	0	14	198	8	6	0	14	206	0.6
9/09	24	0	0	0	0	8	5	2	0	7	205	5	2	0	7	213	0.3
9/10	24	0	0	0	0	8	1	1	0	2	207	1	1	0	2	215	0.1
9/11	24	0	0	0	0	8	3	4	0	7	214	3	4	0	7	222	0.3
9/12	24	0	0	0	0	8	7	8	0	15	229	7	8	0	15	237	0.6
9/13	24	0	0	0	0	8	7	10	0	17	246	7	10	0	17	254	0.7

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Appendix A5.–Page 2 of 2.

	Tagged						Not Tagged					Total					
Date	Hours Fished	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Males	Females	UNK [a] Sex	Total	Cum.	Catch Per Hour
9/14	24	0	0	0	0	8	9	4	0	13	259	9	4	0	13	267	0.5
9/15	24	1	1	0	2	10	3	4	0	7	266	4	4	0	8	275	0.3
9/16	24	0	0	0	0	10	5	3	0	8	274	5	4	0	9	284	0.4
9/17	24	1	1	0	2	12	4	3	0	7	281	5	3	0	8	292	0.3
9/18	24	0	0	0	0	12	6	0	0	6	287	6	1	0	7	299	0.3
9/19	24	0	0	0	0	12	8	1	0	9	296	8	1	0	9	308	0.4
9/20	24	0	1	0	1	13	6	3	0	9	305	6	3	0	9	317	0.4
9/21	24	1	0	0	1	14	3	3	0	6	311	4	4	0	8	325	0.3
9/22	24	2	0	0	2	16	4	5	0	9	320	6	5	0	11	336	0.4
9/23	24	0	0	0	0	16	6	9	0	15	335	6	9	0	15	351	0.6
9/24	24	1	0	0	1	17	5	10	0	15	350	6	10	0	16	367	0.7
9/25	24	0	0	0	0	17	8	12	0	20	370	8	12	0	20	387	0.8
9/26	12	0	0	0	0	17	6	8	0	14	384	6	8	0	14	401	1.1
9/27	24	0	0	0	0	17	7	3	0	10	394	7	3	0	10	411	0.4
9/28	24	0	0	0	0	17	4	5	0	9	403	4	5	0	9	420	0.4
9/29	24	0	0	0	0	17	3	4	0	7	410	3	4	0	7	427	0.3
9/30	24	0	0	0	0	17	6	12	0	18	428	6	12	0	18	445	0.7
10/1	24	1	2	0	3	20	13	23	0	36	464	14	23	0	37	482	1.5
10/2	24	0	0	0	0	20	8	9	0	17	481	8	11	0	19	501	0.8
10/3	24	0	0	0	0	20	2	10	0	12	493	2	10	0	12	513	0.5
10/4	24	0	0	0	0	20	5	11	0	16	509	5	11	0	16	529	0.7
10/5	24	0	0	0	0	20	2	3	0	5	514	2	3	0	5	534	0.2
10/6	24	0	0	0	0	20	2	6	0	8	522	2	6	0	8	542	0.3
10/7	24	0	0	0	0	20	2	2	0	4	526	2	2	0	4	546	0.2
10/8	24	0	0	0	0	20	1	2	0	3	529	1	2	0	3	549	0.1
Total	1,303	14	6	0	20		273	256	0	529		287	262	0	549		

[a] Unidentified sex.

Appendix A6.–Daily effort and catch of coho salmon at the Tanana/Kantishna River mark–recapture project fish wheels, 2005.

	Tanana Tag Deployment			Tanana Tag Recovery			Kantishna Tag Deployment			Toklat Tag Recovery			Kantishna Tag Recovery		
Date	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour
8/16	0	0	0.0	0	0	0.0	1	1	0.1	0	0	0.0	0	0	0.0
8/17	1	1	0.0	1	1	0.0	0	1	0.0	0	0	0.0	0	0	0.0
8/18	2	3	0.1	0	1	0.0	0	1	0.0	0	0	0.0	3	3	0.1
8/19	0	3	0.0	1	2	0.0	0	1	0.0	0	0	0.0	0	3	0.0
8/20	0	3	0.0	0	2	0.0	1	2	0.0	0	0	0.0	1	4	0.1
8/21	0	3	0.0	0	2	0.0	0	2	0.0	0	0	0.0	0	4	0.0
8/22	0	3	0.0	0	2	0.0	0	2	0.0	0	0	0.0	1	5	0.0
8/23	2	5	0.1	1	3	0.0	1	3	0.0	0	0	0.0	0	5	0.0
8/24	0	5	0.0	1	4	0.0	1	4	0.0	0	0	0.0	1	6	0.0
8/25	4	9	0.2	2	6	0.1	0	4	0.0	0	0	0.0	1	7	0.0
8/26	3	12	0.1	1	7	0.0	0	4	0.0	0	0	0.0	1	8	0.0
8/27	3	15	0.3	1	8	0.0	1	5	0.0	0	0	0.0	2	10	0.1
8/28	0	15	0.0	4	12	0.2	1	6	0.0	0	0	0.0	0	10	0.0
8/29	1	16	0.1	11	23	0.5	4	10	0.2	1	1	0.0	2	12	0.1
8/30	0	16	0.0	15	38	0.6	0	10	0.0	0	1	0.0	3	15	0.1
8/31	0	16	0.0	53	91	2.2	2	12	0.1	1	2	0.0	12	27	0.5
9/01	2	18	0.3	59	150	2.5	8	20	0.3	0	2	0.0	4	31	0.2
9/02	2	20	0.2	102	252	4.3	12	32	0.5	1	3	0.0	14	45	0.6
9/03	2	22	0.3	105	357	4.4	2	34	0.1	5	8	0.2	15	60	0.6
9/04	4	26	0.2	253	610	12.2	5	39	0.2	11	19	0.4	40	100	1.6
9/05	3	29	0.1	198	808	11.1	3	42	0.1	21	40	0.9	24	124	1.0
9/06	6	35	0.3	614	1,422	25.6	3	45	0.1	28	68	1.2	26	150	1.1
9/07	5	40	0.2	371	1,793	16.1	5	50	0.2	16	84	0.7	33	183	1.3
9/08	10	50	0.4	475	2,268	19.0	5	55	0.2	5	89	0.2	57	240	2.3
9/09	4	54	0.5	510	2,778	21.3	6	61	0.3	6	95	0.2	29	269	1.2
9/10	8	62	1.2	283	3,061	10.9	12	73	0.5	5	100	0.2	18	287	0.7
9/11	10	72	1.3	317	3,378	13.3	4	77	0.2	12	112	0.5	31	318	1.3
9/12	6	78	0.8	355	3,733	14.8	9	86	0.4	14	126	0.6	46	364	1.9
9/13	7	85	0.9	591	4,324	24.6	7	93	0.3	8	134	0.3	53	417	2.2

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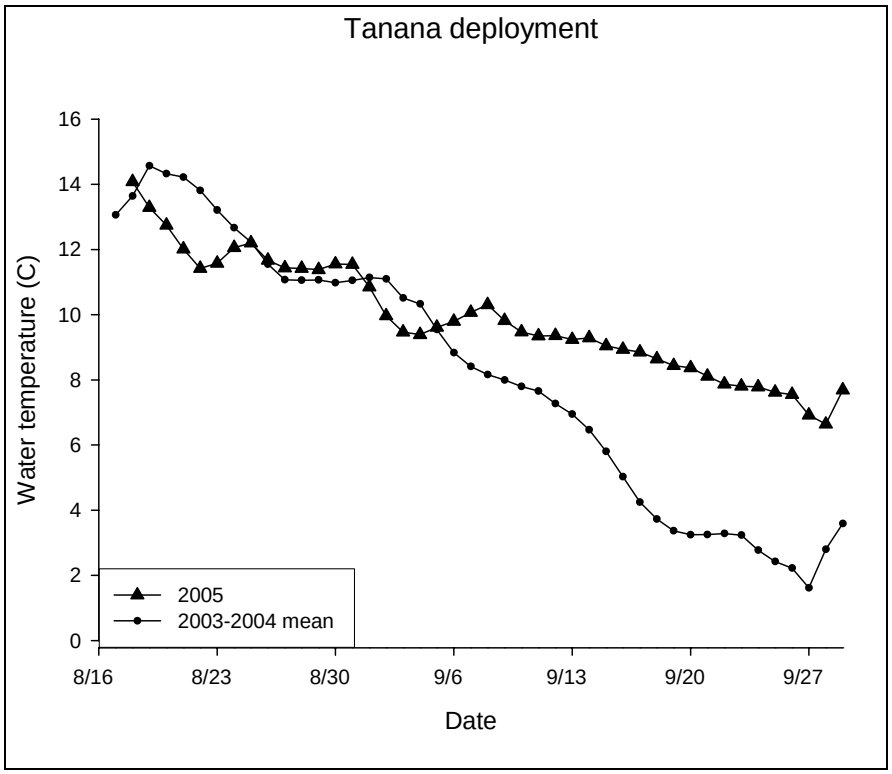
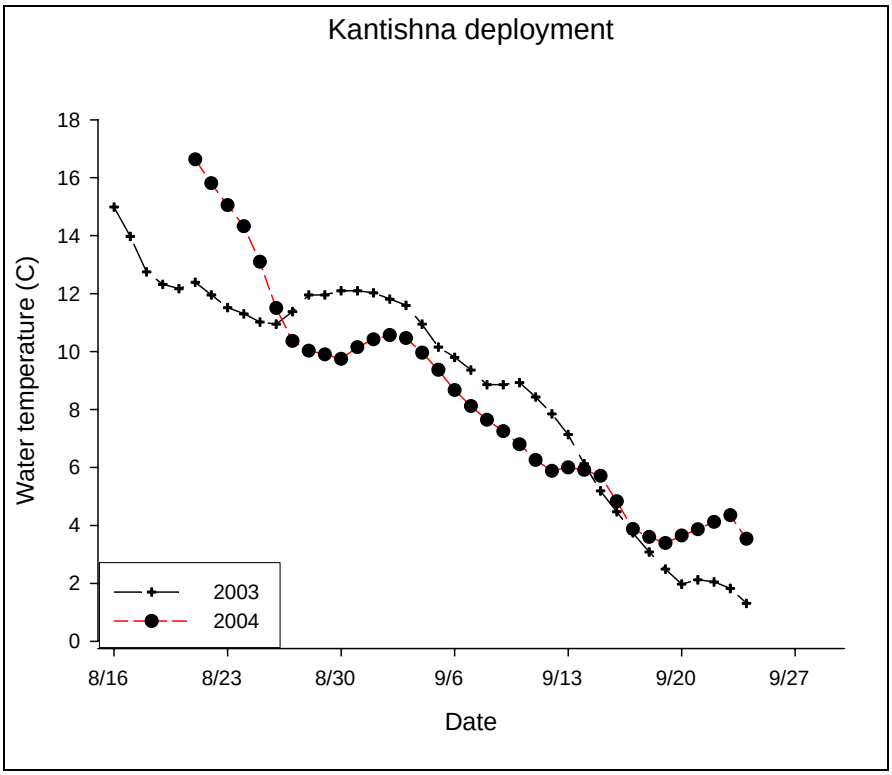
Appendix A6.–Page 2 of 2.

	Tanana Tag Deployment			Tanana Tag Recovery			Kantishna Tag Deployment			Toklat Tag Recovery			Kantishna Tag Recovery		
Date	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour
9/14	6	6	0.8	311	4,635	13.0	15	108	0.6	11	145	0.4	44	461	1.8
9/15	13	19	1.7	492	5,127	20.6	17	125	0.7	14	159	0.6	38	499	1.6
9/16	16	35	2.6	462	5,589	19.3	26	151	1.1	29	188	1.2	48	547	2.0
9/17	13	48	1.9	379	5,968	15.8	13	164	0.5	46	234	1.9	32	579	1.3
9/18	11	59	1.6	417	6,385	17.4	12	176	0.5	43	277	1.8	51	630	2.1
9/19	20	79	2.9	439	6,824	18.5	7	183	0.6	58	335	2.4	27	657	1.1
9/20	8	87	1.1	672	7,496	28.9	9	192	1.0	14	349	0.6	28	685	1.1
9/21	21	108	3.0	450	7,946	18.8	12	204	1.0	15	364	0.6	23	708	0.9
9/22	9	117	1.3	406	8,352	19.0	26	230	2.2	41	405	1.7	26	734	1.1
9/23	0	117	0.0	574	8,926	23.9	38	268	3.2	61	466	2.5	17	751	0.7
9/24	0	117	0.0	356	9,282	14.8	40	308	1.7	43	509	1.8	30	781	1.2
9/25	5	122	0.7	409	9,691	36.0				24	533	1.0	19	800	0.8
9/26	9	131	1.3	489	10,180	46.6				59	592	2.4	26	826	2.1
9/27	6	137	0.5	335	10,515	14.0				54	646	2.2	13	839	0.5
9/28				238	10,753	10.3				81	727	3.3	17	856	0.7
9/29				394	11,147	15.5				56	783	2.3	62	918	2.5
9/30				301	11,448	15.6				53	836	2.2	67	985	2.7
10/1				512	11,960	19.9							51	1036	2.1
10/2				480	12,440	20.0							52	1088	2.1
10/3				165	12,605	8.1							58	1146	2.4
10/4													78	1224	3.2
10/5													58	1282	2.4
10/6													27	1309	1.1
10/7													18	1327	0.8
10/8													20	1347	0.8
10/9													4	1351	0.2
Total	222			12,605			308			836			1,351		

Note: Days with zero indicate days when the project wheels were not operating.

Appendix A7.–Water temperatures at the Tanana/Kantishna River mark–recapture project fish wheels, 2003–2005, and the Toklat River Springs (Geiger Creek), 2004–2005.





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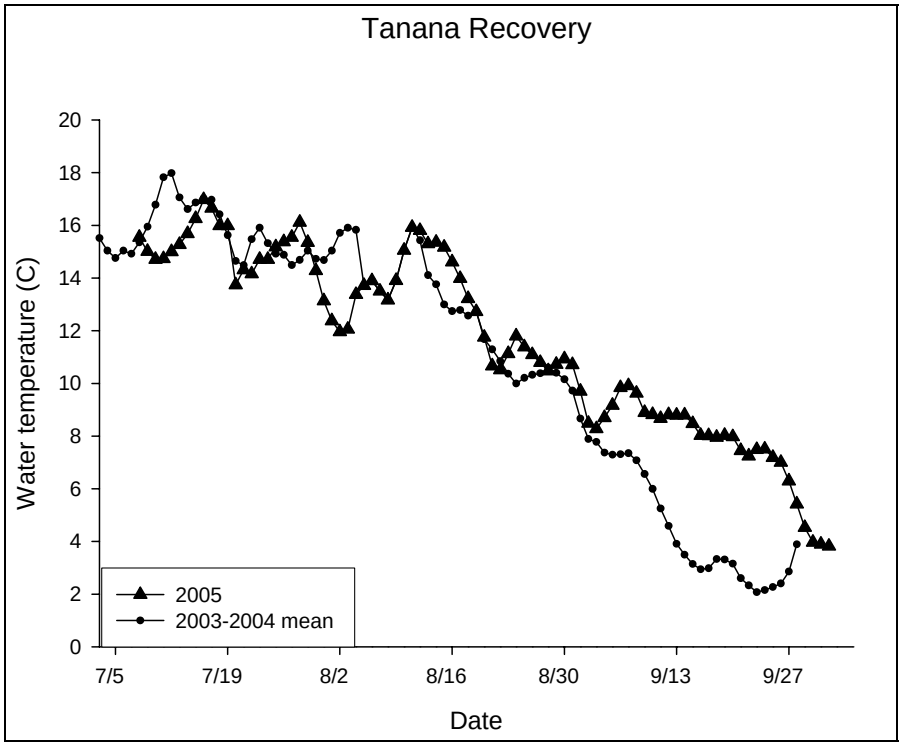
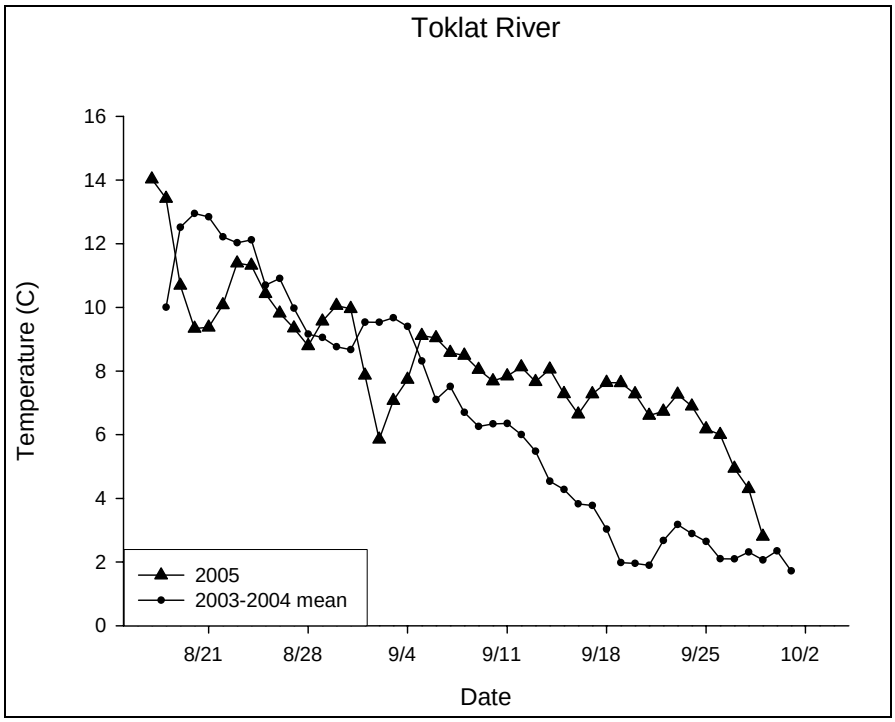
Appendix A7.–Page 2 of 3.





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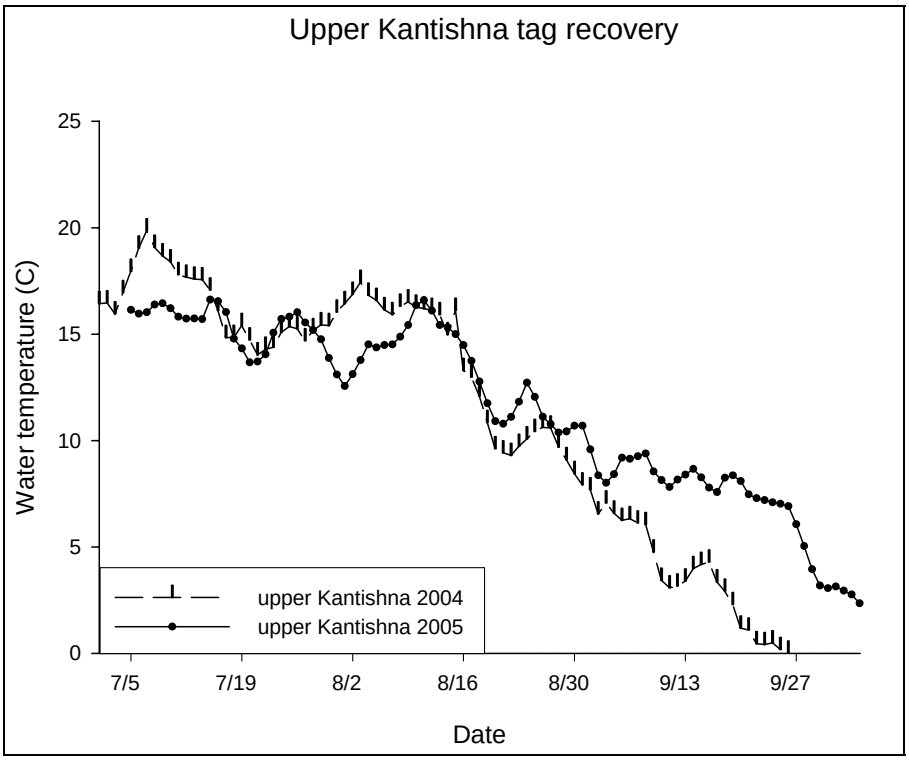
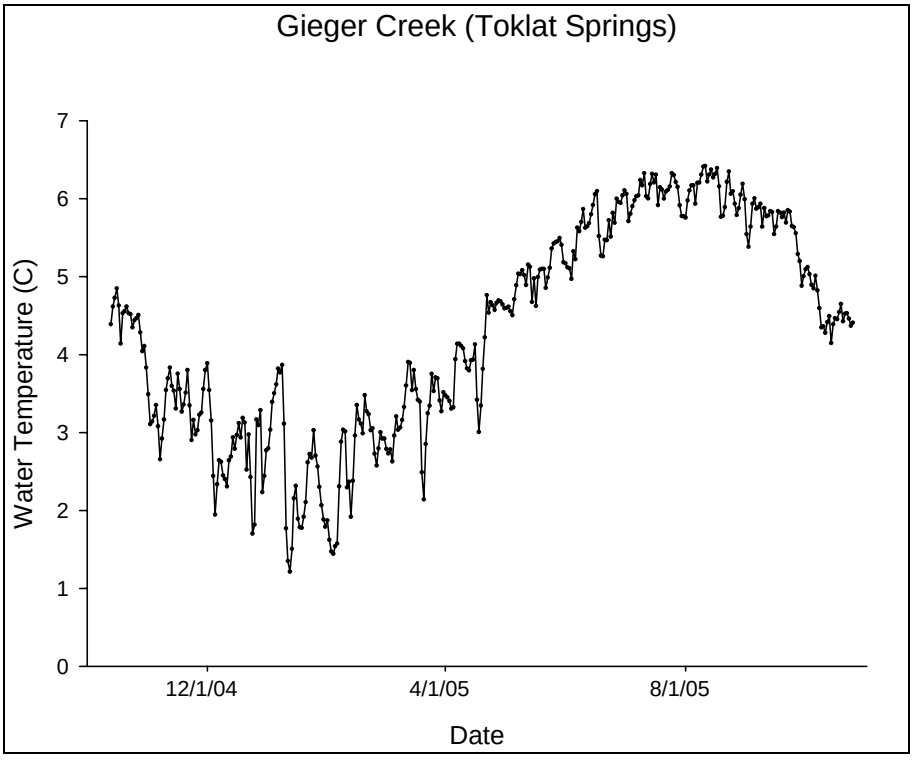

Upper Kantishna tag recovery
Water temperature (C)
25
20
15
10
5
0
upper Kantishna 2004
upper Kantishna 2005
7/5
7/19
8/2
8/16
8/30
9/13
9/27
Date


Gieger Creek (Toklat Springs)
Water Temperature (C)
7
6
5
4
3
2
1
0
12/1/04
4/1/05
8/1/05
Date